STELLAR MASS LOSS AND GALACTIC CHEMICAL EVOLUTION

A. Serrano and M. Peimbert
Instituto de Astronomía
Universidad Nacional Autónoma de México

We summarize here some of the results that we have obtained from chemical evolution models. In particular, we discuss those aspects related to stellar mass loss, helium production, a varying heavy element yield and the very light stars.

The observed value of the helium to heavy element abundance ratio $\Delta Y/\Delta Z$ is about 3 (e.g. Lequeux et al. 1979). First theoretical estimates gave $\Delta Y/\Delta Z = 0.4$ (Hacyan et al. 1976). We have considered in Paper I (Serrano and Peimbert 1980) chemical evolution models that take into account, among other aspects:

i) Mass loss and helium mixing and ejection in intermediate mass stars, based on models of asymptotic giant branch evolution (Iben and Truran 1978; Renzini and Voli 1980).

ii) Mass loss in massive stars (e.g. Chiosi et al. 1978) with its corresponding change in stellar structure (Chiosi and Caimmi 1979).

For the best input values we obtained $\Delta Y/\Delta Z \simeq 3$. This can be seen clearly in Table I, where the effects of intermediate mass stars

TABLE I

$\Delta Y/\Delta Z$ for different assumptions about stellar mass loss

Mass loss in		
IMS	HMS (α)	$\Delta Y/\Delta Z$
no	0	0.4
no	0.9	1.23
RV80	0	1.01
IT78	0.9	2.47
RV80	0.9	3.06

IMS= Intermediate mass stars ($1\ m_\odot < m < 8\ m_\odot$); HMS= high mass stars ($m > 10\ m_\odot$). RV80= Renzini and Voli 1980; IT78= Iben and Truran 1978; α of Chiosi et al. 1978.

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($1\ m_\odot < m < 8\ m_\odot$) and of high mass stars ($m > 10\ m_\odot$) are contrasted. In this table, the difference between models by Iben and Truran (1978) and by Renzini and Voli (1980) is that the latter allow stars between 1 and 2.5 $m_\odot$ to form planetary nebulae (PNII: see Peimbert and Serrano 1980). In massive stars, Chiosi's α= 0.9 corresponds to models with high mass loss while α= 0 corresponds to constant mass evolution models. From Table I it follows that mass loss from high and intermediate mass stars is required to explain the observed $\Delta Y/\Delta Z$ ratio.

Based on recent determinations of the heavy element yield p (e.g. Pagel and Patchett 1975; Lequeux et al. 1979; Talbot 1980; Pagel 1981, see also Paper II: Peimbert and Serrano 1980 and references therein, we suggest in Paper II that p is not constant. It is proposed that p= a + b Z. This relation is consistent with the heavy element abundances in irregular galaxies, blue compact galaxies, the galaxy and M83.

In Figure 1, within the uncertainties of the observations, all galaxies but one (A 1228+15) fall between the simple model and the extreme infall model with M_{gas}=const. (Larson 1972).

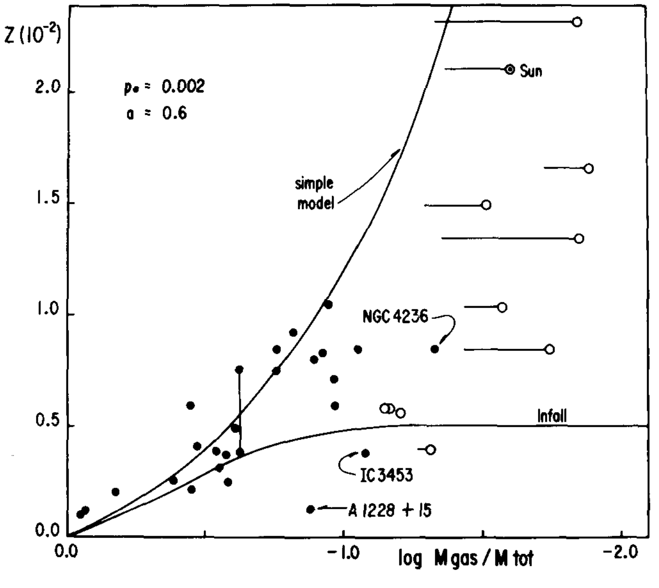

Figure 1. Heavy element abundances as a function of the gas fraction. Dots are irregular and blue compact galaxies, open circles are galactic H II regions (horizontal bars represent corrections for H_2 and the vertical line joins two H II regions in the same galaxy). A variable yield given by p= 0.002+0.6 Z has been used to compute the curves for the simple model and the infall model with M_{gas}= const.

Coupling the conditions $\Delta Y/\Delta Z = 3$ and $p(Z)$ it follows that the relative amount of low mass stars ($m < 1\ m_{\odot}$) decreases with Z. This helps to explain observed gradients in abundances (e.g. Peimbert 1979 and references therein) and in M/L (e.g. Tinsley 1980 a,b; Peimbert and Torres-Peimbert 1981). From constant yield models Larson and Tinsley (1978) obtain M/L values smaller than observed for spiral and irregular galaxies (see Table 2 of Faber and Gallagher 1979). A similar problem has been pointed out by Lequeux et al. (1979). This discrepancy can also be solved by adopting a yield increasing with metallicity.

Subsequent papers of the same series (now in preparation) will deal with M/L ratios and with galactic chemical evolution of nitrogen and carbon.

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DISCUSSION

BECKER: Could you clarify what you mean in saying that the massive stars are responsible for a decrease in ΔZ?

SERRANO: The massive stars when considered with mass loss produce smaller cores as shown by Chiosi and consequently the smaller core results in less metals being added to the interstellar medium.

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